EXPANSION OF EXISTING DIAL CENTRAL OFFICE SWITCHBOARDS

Purpose: The purpose of this addendum is to provide information concerning possible solutions for complex switching and trunking problems resulting from the rapid growth and expansion of existing step-by-step dial telephone systems. A requirement for expanding extended area service or other services may introduce complex trunking patterns which in a step-by-step system may lead to inefficient use of stepping switches. An available means for surmounting these difficulties is the introduction of indirect control facilities into the system through the installation of register-senders with translation features.

Deletions: Delete the heading, "8. USE OF REGISTER-SENDERS WITH DIRECT RESPONSE SWITCHBOARDS" and the paragraph numbered 8.1 in the text of Section 329, Issue No. 1. Make a notation alongside this paragraph, "SEE ADDENDUM NO. 3."

Additions:

8. USE OF REGISTER-SENDERS WITH STEP-BY-STEP SYSTEMS

8.1 A step-by-step switching system is operated primarily by direct control. The switches are actuated from pulses generated by the dial at the calling telephone and the positioning of these switches is associated directly with the digits dialed. By opening circuits between line-finders and local first selectors and inserting access equipment to register-senders with translating facilities, it is possible to divorce the control of the switches from the pulses received directly from the dials.

8.2 The access equipment permits the subscribers to reach the register-senders without making any changes in the existing switches. A register-sender is an electromechanical, electronic or combination device which receives information in dial pulse or tone form and converts it into codes which are presented to a translator. The translator accepts this coded information, processes it through its memory and returns the proper routing information to the register-sender. The register-sender converts this information to the proper mode for outpulsing in dial pulse or multifrequency form as required. The translator is provided with a readily changed memory so it may meet future expansion or different routing requirements.

8.3 The more evident applications for register-senders are as follows:

8.31 When a complex extended area service network is being designed with universal directory numbering, or an existing EAS network is to be expanded, thereby introducing conflicts in a uniform numbering plan, the use of register-senders may eliminate the need for cumbersome multiple stages of step-by-step switching, or in some cases may provide the only possible solution to the switching problem.

8.32 The register-sender can perform the digit absorbing function, thus making it unnecessary to absorb digits in the first selector.

8.33 Sometimes a saving in trunk quantities can be realized by using alternate routing to absorb overflow traffic as directed by register-senders.

8.34 A saving in EAS trunks may result if traffic can be directed through tandem facilities.

8.35 Offices in or near metropolitan areas may be required to send the full
digits to the connecting office. The use o
accomplishing this feature without requiring the e

8.36 Register-senders will permit the introduct
distance dialing (1 + station-to-station; 0 + person-to-person, [illegible]
for special services (411; 1 + 411 information; etc.).

8.37 Register-senders may be arranged to provide the facilities for push button dialing.

8.38 The use of register-senders may provide facilities for MF sending and receiving to and from other common control offices.

8.4 Illustration: FIGURE 2. Register-Sender Control of Step-by-Step Switching System. This figure shows how the access equipment is inserted between linefinders and first selector. An access circuit is required for each linefinder. When a subscriber goes "off-hook" the linefinder finds his line and extends it to the associated access circuit. A link finder is associated with each register-sender and it selects the access circuit requiring service. The subscriber's line is then connected to the register-sender and dial tone is returned from the register-sender to the subscriber.

8.5 When the calling party starts to dial, the digits are received in the register where they are counted on a counting chain and stored in code form during the interdigital time. The register may have some translation capabilities and where these are exceeded it presents the stored codes to the regular translator. When sufficient information has been received in digital form to determine the disposition of the call, the sender will outpulse in the dial pulse mode to actuate the switches. It will then release and the register-sender becomes available for another call.

8.6 If one or more digits as dialed by the subscriber determine that register-sender and translator facilities are not required, these pulses may be absorbed in the switch train and the link to the register-sender released. The circuit between the linefinder and the first selector is now bridged directly and further pulses from the dial are routed directly into the switch train.

EXTENSION OF [illegible] DIAL CENTRAL OFFICE [illegible]

Purpose: The purpose of this addendum is to show that service may be extended beyond a nominal 1500-ohm (including the telephone set) loop from the central office without long line adapters provided the outside plant is predominately buried. A further extension may be obtained if standby auxiliary power equipment with automatic controls is provided to hold the central office voltage at the float value of 51 to 52 volts in case of commercial power failure.

Additions:

9.6 The capability of most 1500-ohm switchboards will be increased to 1700 ohms, a gain of 200 ohms, if the outside plant is predominately buried. The buried plant is not subjected to the extreme variations in temperature as is aerial cable and will be maintained more nearly at the nominal resistance shown in the 68°F. tables. A result can be the use of finer gauge cables at less cost. If the outside plant is part buried and part aerial, for example, 50 percent of each, the gain is proportionately less. (See Figure 1 for mixed aerial and buried plant). If the mixed aerial and buried plant has 10 percent or less of its total resistance above ground, the plant can be considered 100 percent buried.

9.7 A further gain of 200 ohms to a 1900 ohms capability with buried plant can be realized if a standby power source with automatic controls is installed to carry the office load at the float voltage of 51 to 52 volts in case of failure of the commercial power. The standby power source may be a motor generator, or counter cells, or end cells in the central office battery. Two chargers, either of which has the capacity to carry the full load, or as an alternative, two smaller chargers with a combined capacity to carry the full load, are recommended for use with the standby power to maintain a charge on the battery. Refer to TE & CM-325, "Application Guide for the Preparation of Detail Dial Central Office Equipment Requirements," and TE & CM-330, "Emergency Generating and Charging Equipment," for detailed information.

9.8 Caution must be exercised in coordinating various types of interoffice trunks with the intraoffice switching equipment to make sure the extended range is available. The use of certain interoffice trunks such as some types of loop dial carrier, or special DDD trunks, may limit the subscriber loops to lower values than those described in this addendum.

9.9 Before designing the cable plant it will be necessary to test the capability of the individual central office equipment. This test is to be performed at float voltage. Two artificial lines with telephones including ringers are to be made with five-watt or greater resistors. A combination of resistors, which will make each line 1900 ohms with no shunt resistance or capacitance other than the phone and its ringer, are connected to spare line terminals in two separate line groups. Connector terminals from one-half the connector groups are then connected to each line terminal. Make a call through at least 50 percent of the selectors in each group, and 100 percent of the connectors in each group. Answer all calls, check for trip during the silent period, and observe that the answer bridge relay operates properly. Move one artificial line and telephone to a line terminal in a new group and once again call the stationary line and telephone. This time it will not be necessary to call through all connectors. Continue to move this line and telephone until all selector groups have been tested. Make calls on all interoffice trunks, to[illegible]
and EAS. It is also necessary to call operator trunks.
of these tests mean the loop limits of this central off
accordance with Paragraphs 9.6 and 9.7. If these tests
completed, current flow to manufacturer's specification
ring trip relays, which are fai
tests still fail, lower artif
tests can be successf
and 1900 ohms must be
9.6 and 9.7.

9.10 Illustration. Figure
Subscriber Loop When

INSTRUCTIONS OF EXISTING DIAL OFFICE SWITCHBOARDS

Purpose: The purpose of this addendum is to recommend the modification of existing switchboards to increase the present capability of operating over subscriber line loops of 1100 ohms or 1200 ohms to a maximum of 1500 ohms, including the telephone instrument, where plant conditions warrant it.

Addition: 9. INSTRUCTIONS OF EXISTING SWITCHBOARDS TO INCREASE SUBSCRIBER LOOP LIMITS

9.1 Typically the comparison of outside plant designs based on 1100/1200 ohm equipment and 1500 ohm equipment, including the telephone instrument, show very significant savings by using finer gauge cable for the latter. The prospect of these outside plant savings make it fortunate to consider modification of existing switchboards to extend subscriber loop limits at the same time major outside plant construction is accomplished.

9.2 It is possible to extend the line loop limits of many existing switchboards from a present 1100 ohms or 1200 ohms to a maximum of 1500 ohms, including the telephone instrument, by neglecting or readjusting certain dialing, supervisory and ringing relays. Where outside plant savings make such a modification desirable, it is recommended that the supplier of the existing switchboard be consulted about the necessary modifications and the estimated cost.

9.3 In most cases new additions to older switchboards have the 1500 ohm capability, but it cannot always be utilized without modifying the present switchboard.

9.4 Generally the entire existing switchboard should be modified to 1500 ohm capability, thereby permitting any loop, regardless of length (up to 1500 ohms), to be served on any line or trunk of the original office equipment. There may be exceptions to this general rule, so that the resulting switchboard would have some groups with 1500 ohm capability and some with the shorter capability. This arrangement would lack flexibility, but would still be preferable over a switchboard with only 1100 or 1200 ohm capability, providing the people making the line and number assignments can cope with the problem of keeping the longer loops out of the wrong groups.

9.5 If the modification is possible at all, usually the material cost is quite modest. Much of the modification cost consists of labor.

EXPANSION OF EXISTING DIAL CENTRAL OFFICE SWITCHBOARDS

CONTENTS

1. GENERAL

1.1 This section is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design and construction of telephone systems of REA borrowers. It covers in particular major expansions of existing dial switchboards.

2. BASIC INFORMATION

2.1 A major central office expansion may be defined as an addition which exceeds the wired capacity of the switchboard and which will require major units of equipment. These units will include frames, interunit cabling and cable runway. A minor central office addition is an addition of equipment to existing frames where space and wiring are already available. It may consist of only a few lines, linefinders, selectors, connectors or trunks. Minor additions are simple to install and are not within the scope of this section.

2.2 When the major expansion of an existing dial switchboard becomes necessary, careful consideration should be given to the following items: (1) a study of the traffic in the existing equipment to establish the actual unit calls-per-line and per-station and the usage for each intraoffice and interoffice trunk group. Experience has shown that the average unit calls-per-line which were assumed for an initial dial installation often does not fit the particular office and it will be advantageous to determine the actual usage. The methods of making the necessary traffic studies are described in TE & CM-515, "Telephone Traffic - Measurements." This is the only way to make sure that the correct amount of equipment for intraoffice and interoffice trunks will be ordered for the addition. A major expansion also offers a chance to correct unbalanced loads on linefinder and connector groups; (2) a calculation of the probable increase in the power requirements. Connecting companies that are using power from the 48-volt power plant should also be contacted to determine their future requirements. This will show whether the capacities of the existing powerboard, power wiring, battery and charger are adequate for the increased load; (3) a review of the present switching diagram to determine the possible points of access from the present to the proposed equipment. It will also show what directory numbers may be assigned in the new addition and whether any changes will be necessary in existing directory numbers; (4) a review of the present floor plan to determine what space is available for the new equipment or what new space must be provided.

3. TYPES OF SWITCHBOARDS

3.1 Switchboards may be classified according to their basic design as step-by-step switch, motor-switch, all-relay, crossbar, and electronic. The electronic type has not yet come into general use and need not be discussed further in this section.

3.2 Switchboards may further be classified as terminal-per-line and terminal-per-station. The terminal-per-line connector has a terminal assigned for each line regardless of the number of parties on the line. This type of connector usually registers three digits; tens, units, and party. The terminal-per-station connector has a terminal for each station and registers only two

digits; the tens and units. The frequency or code for ringing a station is preassigned to the terminal. Until recently, practically all of the smaller switchboards were terminal-per-line, but for the past several years REA has recommended that most switchboards be terminal-per-station because of the greater flexibility in assigning stations to lines and better compatability with direct distance dialing.

3.3 Some small switchboards with a designed ultimate capacity of 100 lines or less have their linefinders and connectors tied directly together and are referred to as linefinder-connector types. This is also true of some all-relay switchboards which have a designed ultimate capacity of 200 lines and which operate "broadspan," that is, with all the lines having access to all the linefinder-connector links.

3.4 Many switchboards, regardless of the number of lines, have selectors interposed between linefinders and connectors and are called linefinder-selector-connector switchboards, or sometimes just "selector types."

4. EXPANSION OF LINEFINDER-CONNECTOR SWITCHBOARDS

4.1 It may prove to be quite costly to expand a linefinder-connector switchboard beyond its wired capacity. This may be true of step-by-step switch type boards and is almost always true of all-relay types. When selectors must be added the existing connections between the linefinders and connectors must be opened and the selectors interposed. A selector will be required for each of the existing linefinders as well as for each new linefinder. Interoffice trunks presently accessed from connector levels will have to be accessed from the new selector levels. This usually means that connector type interoffice trunks must be replaced with selector type trunks. It is, therefore, suggested that a quotation, including both material and installation be obtained from the equipment supplier before proceeding with a major expansion of a linefinder-connector switchboard in order to make sure that such an expansion is feasible.

5. EXPANSION OF LINEFINDER-SELECTOR-CONNECTOR SWITCHBOARDS

5.1 Usually it is not difficult to expand a linefinder-selector-connector switchboard. All equipment, intraoffice and interoffice, line equipments, etc., are compatible with the new equipment. The new frames should be the same height as the existing equipment. A factor to be considered is the operating range of the expanded switchboard. If the existing equipment was purchased several years ago, it may have a capability of operating over line loops of only 1100 or 1200 ohms. The present specifications for new dial switchboards require a capability of 1500 ohms. When new equipment is purchased to expand an existing switchboard which has a capability of only 1100 or 1200 ohms, some or all of the new equipment may have circuits which are identical with those used on new 1500 ohm switchboards. Nevertheless, the over all capability of the expanded switchboard will not exceed its initial capability. This is true because the new circuits will be working with the older circuits and will be limited by the operating range of the latter.

5.2 It is possible to expand an existing switchboard with equipment of a different manufacturer, or with equipment of the same manufacturer, but of a different type. This usually introduces complications and should not be considered except in unusual cases where it is not feasible to expand with the same type as the existing switchboard. Some of the disadvantages are: (1) complications may be encountered in interconnecting the circuits of two different types of equipment; (2) the access to all interoffice trunks from two types of equipment through adapters if necessary; and (3) the burden of maintaining two different types of equipment with the different adjustments and testing procedures that it involves.

5.3 It should be noted that the expansion of common control equipment may involve the addition of certain common equipment at those stages where the capacity of the existing common equipment is being exceeded. For example, markers, number groups, etc. This will increase the cost and space per line over that of an expansion not requiring the additional common equipment.

5.4 It would be prudent to obtain a quotation covering materials and installation from the manufacturer of the present equipment to determine how much the addition will cost. There have been some cases where it was found more economical to replace the entire switchboard than to make a substantial addition.

6. CHANGING FROM TPL TO TPS

6.1 The preferred standard for new switchboards is terminal-per-station. If a substantial addition is to be made to an existing terminal-per-line switchboard, it may be desirable to make the addition as terminal-per-station or to convert the entire switchboard to terminal-per-station, depending upon the circumstances. Step-by-step switch type and crossbar equipments can be converted from terminal-per-line to terminal-per-station as a general rule. All-relay equipment does not readily lend itself to conversion to terminal-per-station operation. Step-by-step switch type equipment will usually require the addition of bunching blocks at the distributing frame for deriving party lines. A different interrupter will also be required to provide terminal-per-station features. If automatic toll ticketing or automatic number identification (ANI) is equipped, the identifier must be capable of identifying terminal-per-line, terminal-per-station or both as required. If the entire switchboard is being converted from terminal-per-line to terminal-per-station, it may be found to be more economical to replace the existing connector circuits rather than attempt to modify them. The switches can usually be reused. Other elements, such as line equipments, linefinders, and selectors, can be reused without change. Crossbar equipment can usually be converted from terminal-per-line to terminal-per-station by the addition of one or more number groups. The supplier of the equipment should be consulted about the plans for expansion so that important details will not be overlooked and the cost determined.

7. MODIFICATION OF EXISTING LONG LINE ADAPTERS

7.1 During the expansion of the central office, it may be found necessary to provide 72 volts at the long line adapters as described in TE & CM-325, "Application Guide for the Preparation of Detailed Dial Central Office Equipment Requirements," Paragraph 2.062. The existing long line adapters may not have been arranged initially to tap into an auxiliary 24-volt power supply as described in the latest issue of the central office equipment specifications, REA Form 558. If not, these adapters can be modified and a booster power supply added to increase the available voltage from 48 volts to 72 volts where this procedure would overcome transmission problems. It should be understood that this procedure may not necessarily increase the range of the existing long line adapter to 3000 ohms, although the current in the line will be increased. The increased current will help in the operation of bridged tap isolators where low current flow in existing long line adapters is a problem. Under no circumstances should this modification be used in the expectation that it is a substitute for the proper use of loading coils and the maintenance of proper end sections as described in REA TE & CM-424, "Design of Subscriber Loop Plant."

8. USE OF REGISTER-SENDERS WITH DIRECT RESPONSE SWITCHBOARDS

8.1 The numbering pattern for an existing step-by-step switchboard may become too complex to be handled by the conventional direct response circuitry or facilities for customer key pulsing may be required. It is now possible to interpose a bank of register-senders between the present linefinders and selectors which will, in effect, convert the switchboard into a common-control step-by-step system. This provides translation facilities to handle complex numbering plans for toll and extended area service and also customer key pulsing. Other features may be added with the aid of register-senders, such as MF signaling, alternate routing, class of service marking, etc. Further information is contained in REA TE & CM-350, "Basic Types of Switching Systems." If the expansion of the system introduces problems in numbering or pulsing, it is suggested that the supplier of the central office equipment be consulted about whether a register-sender is a requirement to solve the problem.

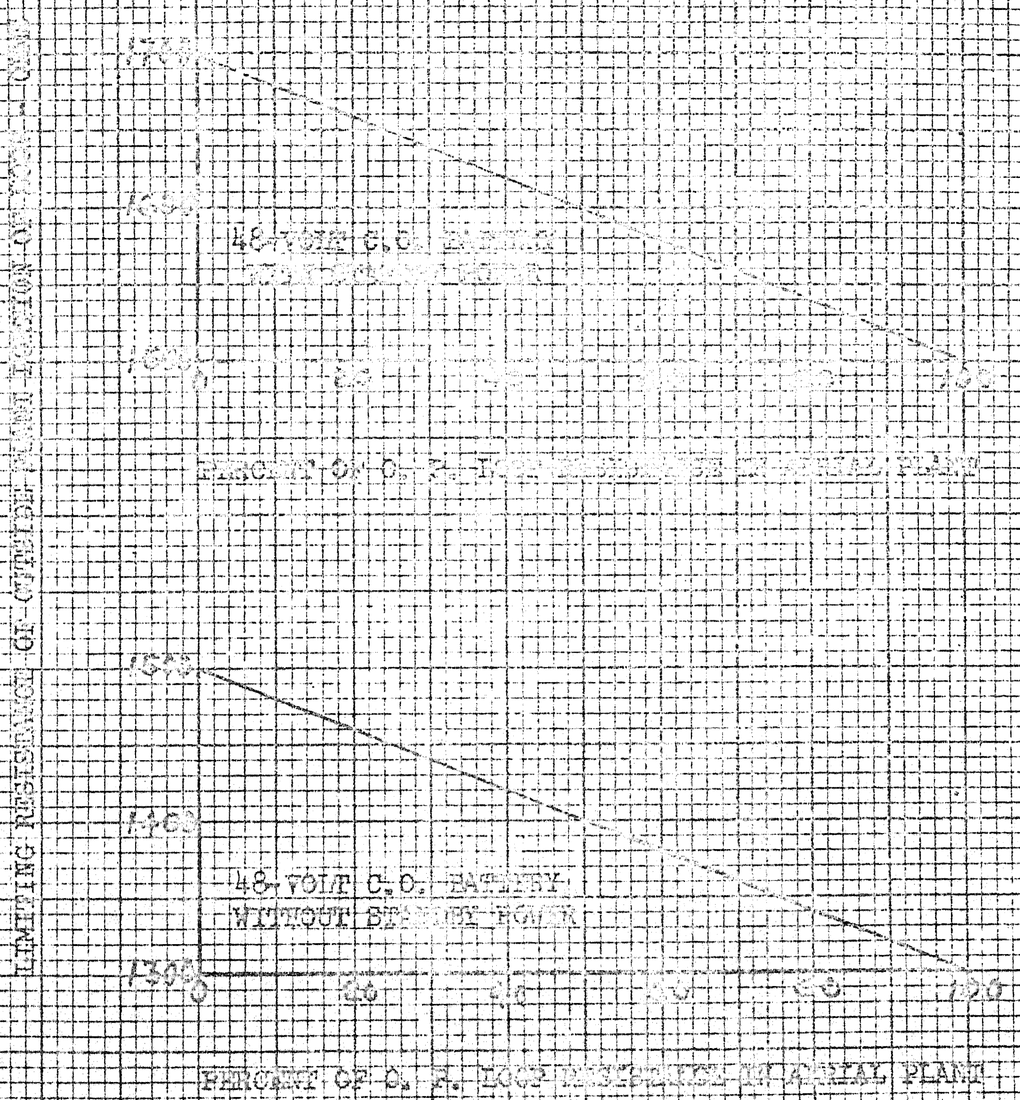
LIMITING RESISTANCE OF OUTSIDE PLANT
48-VOLT C.O. BATTERY
1300
0
100
PERCENT OF O. P. LOOP

FIGURE 2

REGISTER-SENDER CONTROL OF STEP-BY-STEP SWITCHING SYSTEM